MARINE PROTECTED AREAS EFFECTIVELY MAINTAIN ENDEMIC *PINNA NOBILIS* POPULATIONS

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Introduction

Coastal degradation, habitat fragmentation and habitat losses undermine marine biodiversity, especially sessile species. Populations of fan shell *Pinna nobilis*, the endemic and vulnerable largest bivalve in the Mediterranean are declining in spite its legal protection. Climate change, invasive species, contaminants, food web alterations, habitat loss and anchoring are the main treats affecting *Pinna nobilis* populations.

In Marine Protected Areas (MPAs) the fan mussel population densities peak at 9 m depth, decreasing with depth in and decreasing densities are expected with increasing exposure to waves (1).

Cumulative impacts at coastal areas are increasing and responses of key species might provide clues for management actions fostering environmental protection. Knowledge of key process and factors shaping endangered species and linked marine ecosystems are essential to provide appropriate management strategies for coastal species conservation.

Aims

To model the effects of environmental and human stressors in the distribution and abundance of fan mussel *Pinna nobilis* populations at mesoscale level.

Results

- ✓ Spatial distribution and density of fan shell mainly determined by human stressors, while environmental variables influence the size structure (Table 1) .
- ✓ Habitat protection (MPAs) influence *P. nobilis* structure (fig 2)
- ✓ Anchoring highly impacts densities by physical aggression (Table 1)

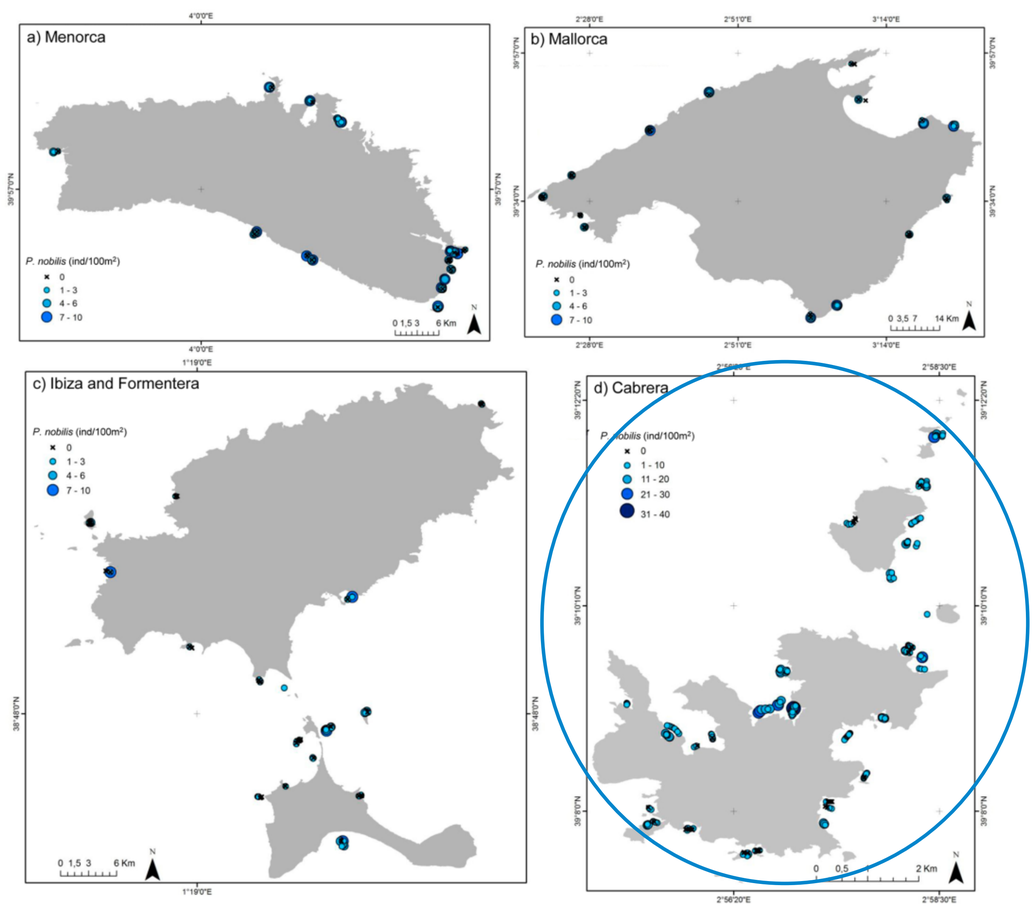

Fig 2. *Pinna nobilis* densities (ind/100m^2) found across islands and localities.

Material and Methods

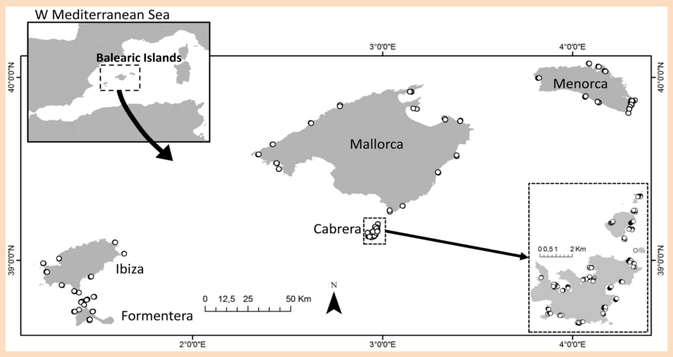

Fig 1. *Pinna nobilis* populations sampled at MPAs and non-MPAs

Sampling and field work

Scuba diving: 661 visual census, depths 10 and 20 m (2011-2013). Strip transects (75 m^2) at *Posidonia oceanica* seagrass meadows. Several island and islets with differing protection status of the locations (Fig 1.)

Statistical analyses

Multivariate models (DistLM distance-based linear model routine marginal test) to assess relationships between environmental variables and human-derived stressors at Balearic Islands, W Med:

- ➢Environmental variables: mean depth, Hs mean, Hs maximum, mean Tp and mean direction
- ➢Human-derived stressors: anchoring, protection status, sewage effluents, fishing activity and diving

	Pinna nobilis density			*Pinna nobilis* size		
Explanatory variable	**% var.**	**Pseudo-*F***	***p***	**% var.**	**Pseudo-*F***	***p***
Mean depth	<0.01	0.0079	0.9658	**7.1**	130.6	**0.01**
Hs mean	0.81	43.023	**0.0204**	0.18	3.12	0.072
Hs maximum	0.16	0.8431	0.3182	<0.01	1.063	0.304
Mean Tp	0.18	0.9655	0.2789	1.62	28.117	**0.001**
Mean direction	2.55	13.579	**0.0001**	4.007	71.3	**0.001**
Anchoring	**19.93**	106.16	**0.0001**	3.918	69.656	**0.001**
Protection status	**11.72**	62.412	**0.0001**	3.296	58.214	**0.001**
Sewage effluents	<0.01	0.1216	0.7044	0.922	15.904	**0.001**
Fishing activity	4.38	23.343	**0.0001**	**3.877**	68.897	**0.001**
Diving	6.05	32.255	**0.0001**	1.33	22.985	**0.001**

***Pinna nobilis* density Major Variable**	**% var.**	**Pseudo-*F***	***p***
Environmental	6.602	92.603	**0.001**
Human	**21.575**	36.039	**0.001**

Table 1. DistLM (distance-based linear model routine) marginal test for relationships among environmental (mean depth, Hs mean, Hs maximum, mean Tp and mean direction) and human variables (anchoring, protection status, sewage effluents, fishing activity and diving) for: *P. nobilis* densities, sizes and *P. nobilis* densities, major variables

Discussion

This large-scale study with high spatial resolution demonstrates:

- ✓ spatial distribution of *Pinna nobilis* is distressed by human stressors more than environmental variables.
- ✓ Anchoring is the main factor affecting density.
- ✓ Legal protection of habitats crucial for maintaining population structure of large, long-lived and sessile benthic organisms.
- ✓ Protection is widely affecting densities at the studied geographical extent. Contrasted densities are two-fold in MPA (Cabrera) no-take reserves have been effectively set >20 years.

MPAs guarantee conservation demonstrating that combination of protection, size and age MPAs seems to set optimal conditions for growth development species.

Human derived impacts in the coastal zones must be properly addressed to guarantee protection of coastal benthic communities. Altogether, indicating that global change processes might be not as relevant as human-derived impacts.

Acknowledgments

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References

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